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(71) Applicant *(for all designated States except US)*: MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD. [JP/JP]; 1006, Oaza Kadoma, Kadoma-shi, Osaka 571-8501 (JP).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: MATSUI, Masatomo [JP/JP]; 554-5, Oomachi, Saijo-shi, Ehime 793-0030 (JP). BANDO, Katsuhiko [JP/JP]; 1727-2, Hagyu, Niihama-shi, Ehime 792-0050 (JP). KOUYAMA, Yoshihisa [JP/JP]; 518-5, Kitadai, Toyo-shi, Ehime 799-1343 (JP). SONE, Koji [JP/JP]; 1942-33, Oojoin, Niihama-shi, Ehime 792-0060 (JP). SEO, Naoyuki [JP/JP]; 813-1, Oomachi, Saijo-shi, Ehime 793-0030 (JP).

(74) Agents: IWAHASHI, Fumio et al.; Matsushita Electric Industrial Co., Ltd., 1006, Oaza Kadoma, Kadoma-shi, Osaka 571-8501 (JP).

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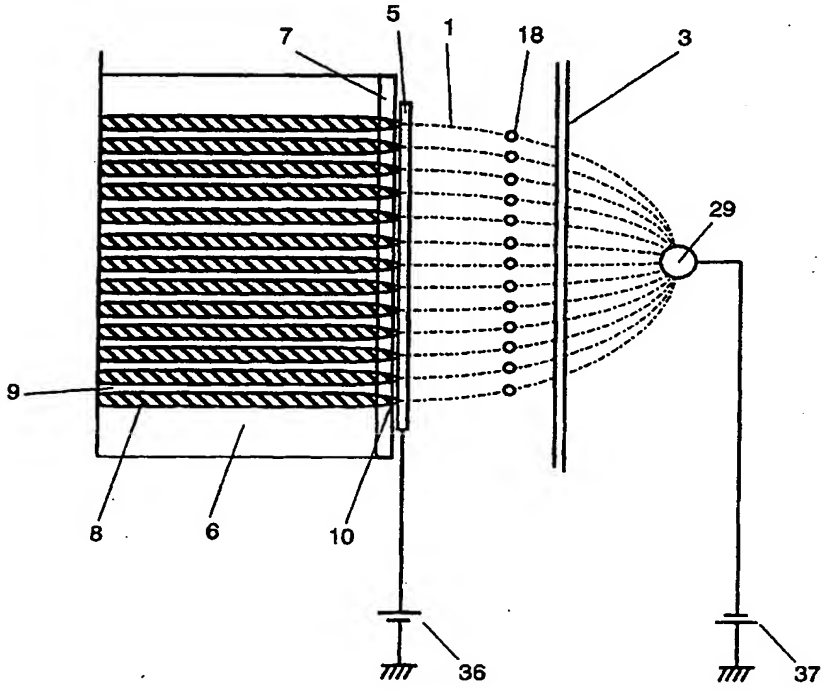
(54) Title: INK JET RECORDING APPARATUS

(57) Abstract

The present invention relates to an ink jet recording apparatus that prints by ejecting ink onto recording media. The ink jet recording apparatus achieves high density recording on the recording media without narrowing the pitch of nozzle holes. The ink jet recording apparatus charges sprayed ink drops by a charging electrode (5), applies a high voltage on a deflecting electrode (29) placed in a position facing the center of a plurality of nozzle holes (10) disposed in a line, and controls flying paths of the ink drops (18). The ink drops are electrostatically deflected by the high voltage, fly through the flying path converging toward the deflecting electrode, and reach to the recording face. Thus, the ink jet recording apparatus which achieves high density recording can be provided without using narrow pitch nozzle holes, which requires a difficult machining process and is difficult to manufacture.



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DESCRIPTION

# INK JET RECORDING APPARATUS

## FIELD OF THE INVENTION

The present invention relates to an ink jet recording apparatus that achieves high density recording by spraying ink from a plurality of nozzle holes to enhance the concentration of ink drops on recording media such as paper and plastics.

## BACKGROUND OF THE INVENTION

As a head for a conventional ink jet recording apparatus, thermal ink jet heads, piezoelectric transducer-type ink jet heads which use piezoelectric elements, and sound-wave-controlled ink jet head have been commercialized. Fig. 4 shows a perspective view of the main parts of ink jet recording apparatus using a piezoelectric transducer-type ink jet head.

In Fig. 4, a nozzle plate 7 is disposed on part of an actuator 6. On one side of the actuator 6 are a plurality of parallel bulkheads 6 made from piezoelectric ceramic, and which extend toward the nozzle plate 7. The bulkhead 6 has a plurality of ink channels 8. Sizes of the actuator 6 and bulkheads 9 need to be very precise. Therefore, they are integrally formed with the same piezoelectric ceramics material. On the nozzle plate 7 are a plurality of nozzle holes 10 correspondingly made with the channels 8 at

regular intervals on a line.

An actuator cover 14 is made from a ceramics material or a plastic material. The actuator cover 14 is formed such that along with the actuator 6, it sandwiches the bulkheads 9. From a ink supply hole 13 ink is supplied to the channels 8 formed on part of the actuator cover. The manifold 17 supplies ink sent from an ink container (not illustrated) to the channels 8 evenly. The ink jet head is constructed as described above.

Signal electrodes 11 are formed by sputtering or vapor deposition on part of the actuator-cover side bulkheads 9. A printed circuit board 12 is connected to a voltage generating circuit (not illustrated) which generates voltage that changes voltage into pressure.

Terminal electrodes 15 are disposed on the printed circuit board 12. A bonding wire 16 supplies voltage to the signal electrodes 11 via the terminal electrodes 15.

The bulkheads 9 are polarized in the depth direction of the grooves, and are deformed depending on the amount of applied voltage on the signal electrodes 11. Along with the deformation, ink filling the channels 8 is sprayed selectively from the nozzle holes 10 which are connected to the channels 8.

Fig. 5 shows a plan view illustrating a main part of a conventional ink jet head. In Fig. 5, ink drops 18 are sprayed from the nozzle holes 10. The ink drops 18 are sprayed at regular intervals, fly along paths 1 and parallel to one another and reach onto recording media 3.

With the conventional construction mentioned above, the pitch of the nozzle holes determines flying paths of the ink drops, and the ink drops

reach onto the recording media along the flying paths. In other words, the pitch of the nozzle holes determines the resolution of recording. In order to enhance the resolution, the pitch of the nozzle holes must be narrowed. However, machining of the bulkheads and the channels is difficult, since they are made of piezoelectric ceramic, and machining requires a blade using diamond abrasive. Thus, a density of the recording is limited with the ink jet head with the conventional construction.

## DISCLOSURE OF THE INVENTION

The ink jet recording apparatus of the present invention has a deflecting electrode for deflecting the pitch of ink jet drops sprayed from the nozzle holes. The ink jet recording apparatus also includes charging means for charging the ink drops. The deflecting electrode and nozzle holes move maintaining their positions relative to each other. The deflecting electrode is disposed on the ink jet head facing the back of the recording face of the recording media.

With the construction disclosed in the present invention, pitch between the ink drops reaching onto the recording media can be narrowed without decreasing the pitch and sizes of the nozzle holes of the ink jet head. Thus high-density recording becomes possible.

## BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1A shows a front view of the main part of ink jet recording

apparatus of a preferred embodiment of the present invention;

Fig. 1B shows a side view of elements of the ink jet head;

Fig. 2 shows a plan view illustrating the flight paths of the ink drops ejected from the ink jet head of the ink jet recording apparatus of the present invention;

Fig. 3 shows a perspective view of the ink jet head of the ink jet recording apparatus of the present invention;

Fig. 4 shows a perspective view of the ink jet head of the prior art ink jet recording apparatus; and

Fig. 5 shows a plan view illustrating the ink drops ejected from the ink jet head of the prior art ink jet recording apparatus.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The ink jet recording apparatus of the present invention includes the following elements:

a) an ink jet head with a plurality of nozzle holes, and which moves transversely to the delivering direction of the recording media;

b) a deflecting electrode for deflecting ink drops sprayed from the nozzle holes, and which maintain relative positions with the nozzle holes; and

c) a high voltage generator for applying high voltage to the deflecting electrode.

And, the deflecting electrode is disposed on the ink jet head facing to the back of the recording face of the recording media.

The ink jet recording apparatus of the present invention has a

charging electrode near the nozzle holes for charging the ink drops if necessary, and a charging voltage generation means for applying voltage to the charging electrode.

The construction of the ink jet recording apparatus of the present invention allows narrowing the pitch of the ink drops reaching onto the recording media, thereby achieving a high density recording.

Secure and stable narrowing of the pitch of the sprayed ink drops onto the recording media becomes possible by charging the sprayed ink drops, thus achieving a high density recording.

Further, since the deflecting electrode is disposed on the ink jet head facing the back of the recording face of the recording media, the deflecting electrode needs not to be disposed in the limited small space between the ink jet head and the recording media. Due to this disposition, the deflecting electrode does not obstruct the flying paths of the ink drops, thus allowing the deflecting electrode to be disposed at the optimal positions.

First preferred embodiment

The preferred embodiments of the present invention are described below with reference to Fig. 1 and Fig. 3. In the Fig.s, the parts which have the same function as those of the prior art carry the same numbers.

Fig. 1A shows a front view of the main part of ink jet recording apparatus of a preferred embodiment of the present invention.

In Fig. 1A, a motor 21 rotates a feed screw A 25 via a gear A 22 and a gear B 23 which engages the gear A 22. A feed screw B 26 cut inversely to a feed screw A 25 rotates combined with a gear C 24. With this construction an

ink jet head 20 and its mounting board 30 are formed such that their relative positions are maintained fixed all the time. A rotating shaft 28 is a rotation centers of the feed screw A 25 and the feed screw B 26. A round-shaped electrode 29 is placed in a position facing approximately the center of a plurality of nozzle holes (described later) disposed in a line.

The mounting board 30 holds the deflecting electrode 29. A guide 31 prevents flexure of the recording media 3. The feed screws A 25 and B 26 are placed parallel to each other. They are maintained such that they can rotate around the rotating shafts 28 that are supported by a frame 32.

In between an ink jet head 20 and the deflecting electrode 29 is the recording media 3 which is maintained by a platen roller 35. The platen roller 35 delivers the recording media 3. The ink jet head 20 and the mounting board 30 are driven together while their relative positions fixed by the feed screws A 25 and B 26. Therefore, relative positions of the deflecting electrode 29 and the nozzle holes are constantly maintained.

A charging voltage generation means 36 generates charging voltage to be applied to a charging electrode (described later). A deflecting voltage generation means 37 applies high negative voltage to the deflecting electrode 29.

Fig. 1B shows a side view of elements of the ink jet head.

In Fig. 1B, an engaging section A 33 is disposed on the feed screw A 25 side of the ink jet head 20 and engages with valleys of the feed screw A 25. And, the engaging section A 33 sends the ink jet head 20 transversely to the delivering direction of the recording media 3 when the motor 21 rotates.

An engaging section B 34 is disposed on the feed screw B 26 side of

the mounting board 30 and engages with valleys of the feed screw B 26. And, the engaging section B 34 sends the mounting board 30 transversely to the delivering direction of the recording media 3 when the motor 21 rotates. In other words, the above-mentioned construction allows the ink jet head 20 and the deflecting electrode 29 to move transversely to the delivering direction of the recording media 3 by the motor 21.

Fig. 2 shows a plan view illustrating the ink drops ejected from the ink jet head of the ink jet recording apparatus.

In Fig. 2, a charging electrode 5 positively charges ink drops 18 sprayed from nozzle holes 10 as they pass through the charging electrode 5. The charging voltage generation means 36 illustrated in Fig. 1 applies voltage to the charging electrode 5.

The round-shaped electrode 29 is applied with high negative voltage by the charging voltage generation means 37.

In Fig. 2 and Fig. 3, the box-shaped charging electrode 5 surrounding all the nozzle holes 10 is hollow inside so that the ink drops 18 can pass through.

After ejected, the ink drops 18 are positively charged by the charging electrode 5, and electrostatically deflected by a high negative voltage between minus one thousands and minus several thousands of the deflecting electrode 29. If the surface of the recording media 3 is negatively charged and the potential of a round-shaped deflecting electrode 4 is low due to the deflecting electrode 29, neutralization occurs when the ink drops 18 are sprayed onto the recording media 3. As a result, electric force lines are changed leaving an insufficient deflection. In order to prevent such

neutralizing effect, the potential of the deflecting electrode 4 should be desirably set between minus one thousands and minus several thousands.

Any kind of conventional high voltage generator can be used for the deflecting voltage generation means 37. As the deflecting voltage generation means 37 simply provides an electric field, and does not require a large electric current, even a light weight and compact device such as a piezoelectric transformer can be used as the deflecting voltage generation means 37.

With the foregoing construction, the ink drops 18 reach the recording face of the recording media 3 via the flying paths 1 which converge into one spot toward the deflecting electrode 29 as illustrated in Fig. 2.

In other words, according to the ink jet recording apparatus of the present invention, intervals of the ink drops 18, namely the recording density, can be changed, while maintaining the pitch of the nozzle holes 10 constant, by changing the relative distance between the nozzle holes 10 , the recording media 3 and the deflecting electrode 29.

By including the deflecting electrode 29 and charging the ink drops 18, recording density on the recording media can be enhanced. A difficult machining of the ink jet head can be avoided. Thus, the recording density that has been conventionally determined by the pitch of the nozzle holes can be enhanced at remarkably low cost.

In the foregoing description, the charging electrode 5 is a hollow box-shaped, however, the charging electrode 5 can be in any shape providing it charges and allows the ink drops 18 to pass through inside.

Other possible charging means include corona charging, which can be utilized by introducing a metal mesh or fine metal lines applied by a high

voltage near the nozzle holes 10. Blowing ion wind generated by an ion generating device near the nozzle holes 10 is another possible method.

By utilizing highly insulating materials such as plastics and ceramics materials for the nozzle plate 7, and mixing charging controlling materials such as metal soaps with ink, ink drops can be charged just by being ejecting from the nozzle.

A conductive materials can also be used for the nozzle plate and make the potential of the ink drops 18 zero. In this case, a charging voltage generation means 36 for the charging electrode is not necessary.

In the foregoing description, the ink drops 18 are positively charged, and the deflecting electrode negatively charged with high voltage. However, negatively charged voltage and positively charged high voltage can be applied to the charging electrode and deflecting electrode respectively.

The ink jet head 20 and the mounting board 30 are driven by the same motor 21 in the description mentioned above. However, they can be driven by different motors. The ink jet head 20 and the mounting board 30 can be integrally formed.

## INDUSTRIAL APPLICABILITY

The ink jet recording apparatus of the present invention converges the ink drops toward the deflecting electrode by utilizing the ink jet head comprising the ink ejection heads, the charging electrode and the deflecting electrode. If necessary, the ink drops can be charged by charging means. With the construction of the present invention, recording density of the ink jet recording apparatus can be enhanced. As the ink jet recording apparatus of

the present invention accelerates the ink drops charged by the charging means, an influence caused by the change in environmental factors such as air flow and temperature near the recording apparatus on the ink can be restricted. Thus, printing of even higher precision can be made possible.

As have been described, according to the present invention, an ink jet recording apparatus which realize high recording density at low cost can be provided. Thus, significant industrial benefits can be expected.

# CLAIMS

1. An ink jet recording apparatus comprising:

a) an ink jet head with a plurality of nozzle holes, and which moves transversely to a delivering direction of a recording medium;

b) a deflecting electrode for deflecting ink drops ejected from the nozzle holes, and which moves maintaining relative positions with the nozzle holes; and

c) a high voltage generator for applying a high voltage to the deflecting electrode.

2. An ink jet recording apparatus comprising:

a) an ink jet head with a plurality of nozzle holes, and which moves transversely to a delivering direction of a recording media;

b) a charger for charging ink drops ejected from the ink nozzles;

c) a deflecting electrode for deflecting the ink drops, and which moves maintaining relative positions with the nozzle holes; and

d) a high voltage generator for applying high voltage on the deflecting electrode.

3. The ink jet recording apparatus of claim 1 or claim 2, wherein the deflecting electrode is disposed on a position facing a back surface of a recording surface of the recording medium.

FIG. 1A

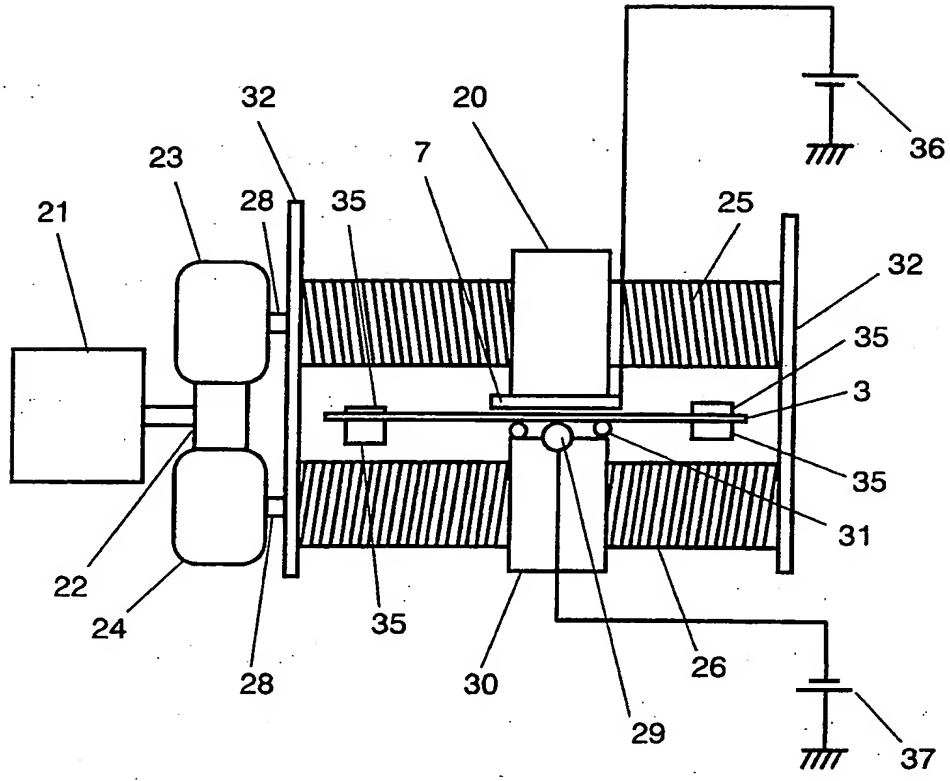
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FIG. 1B

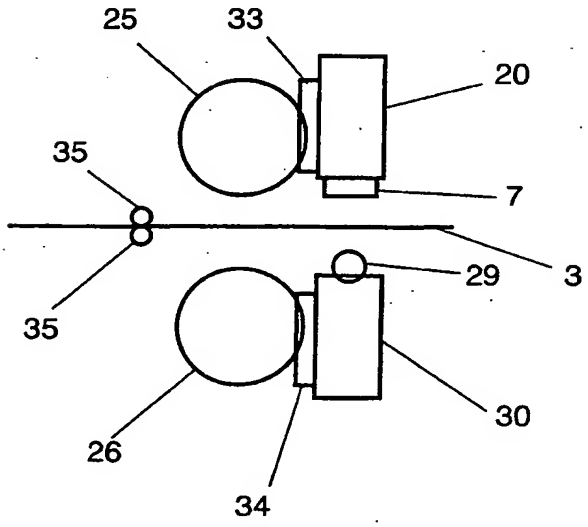
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FIG. 2

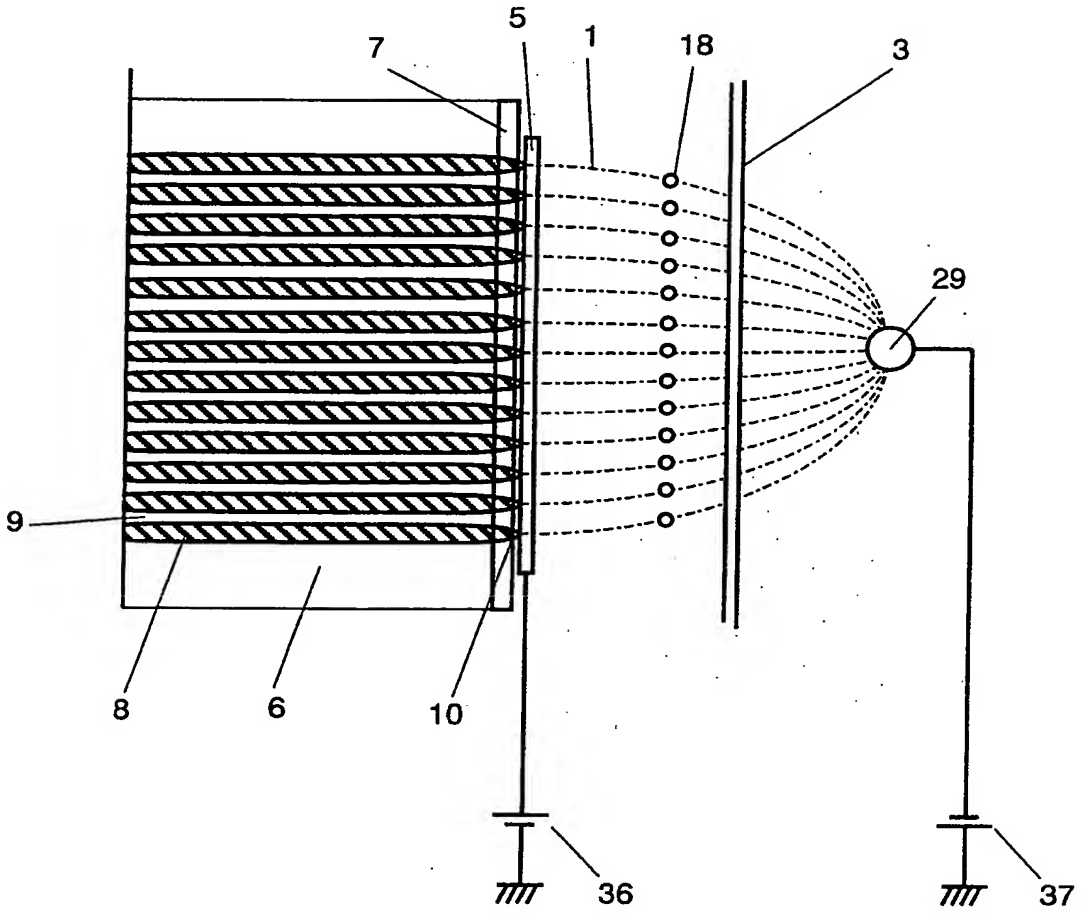


FIG. 3

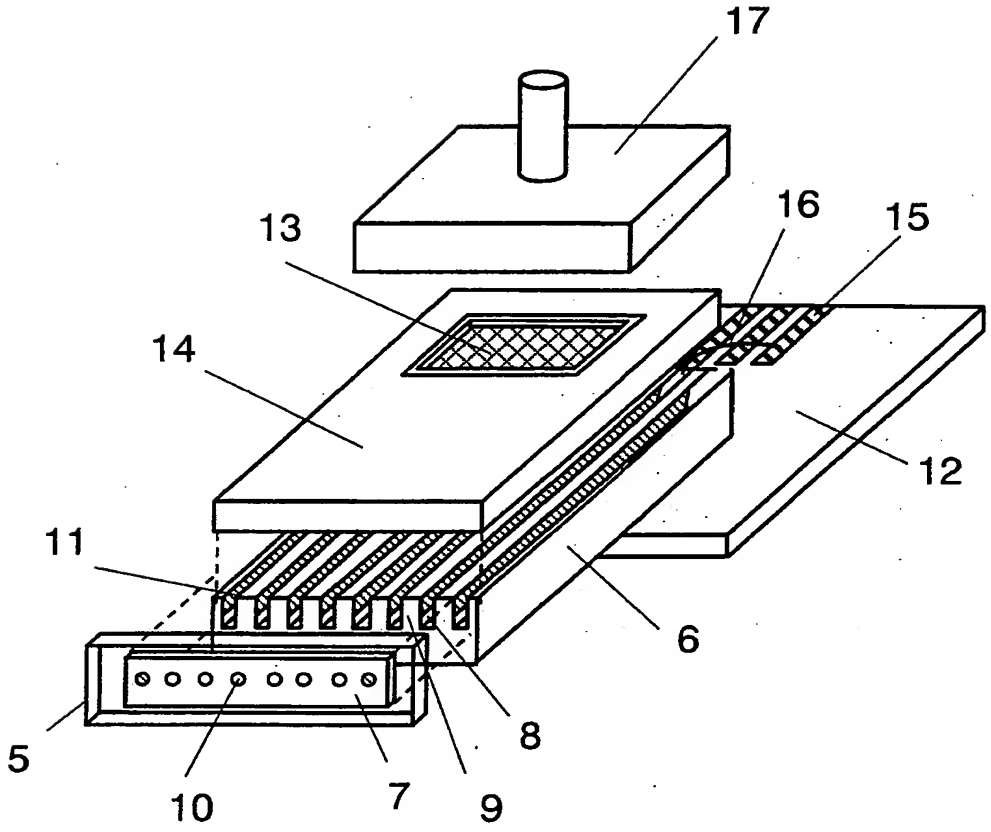


FIG. 4

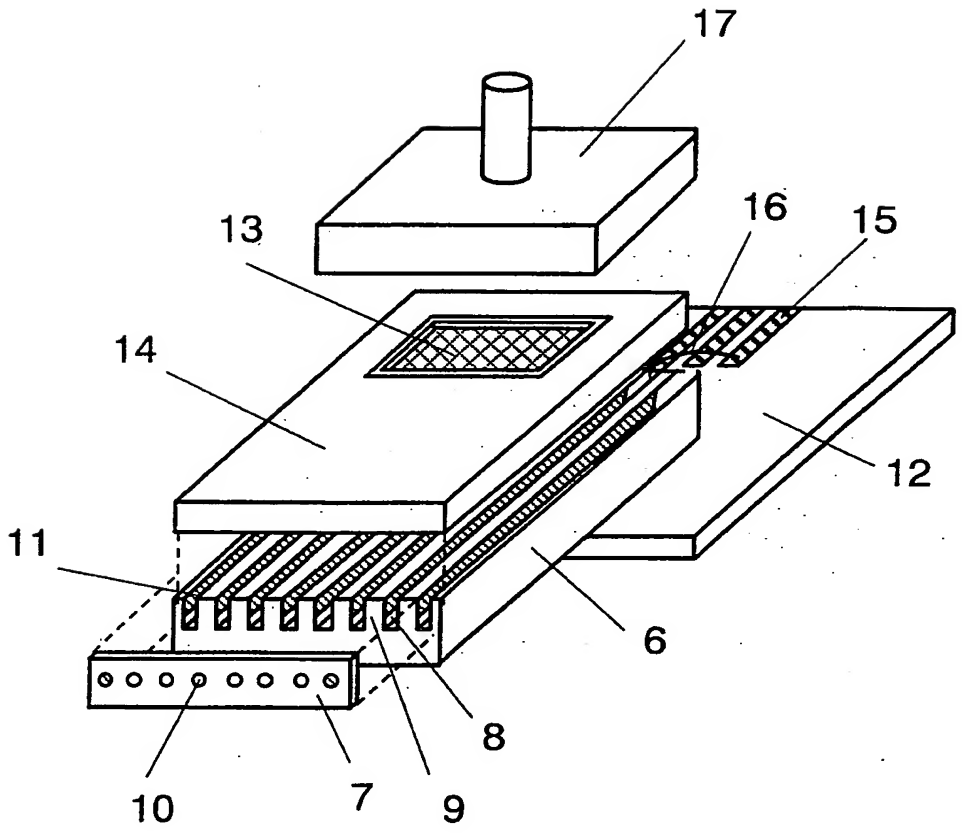
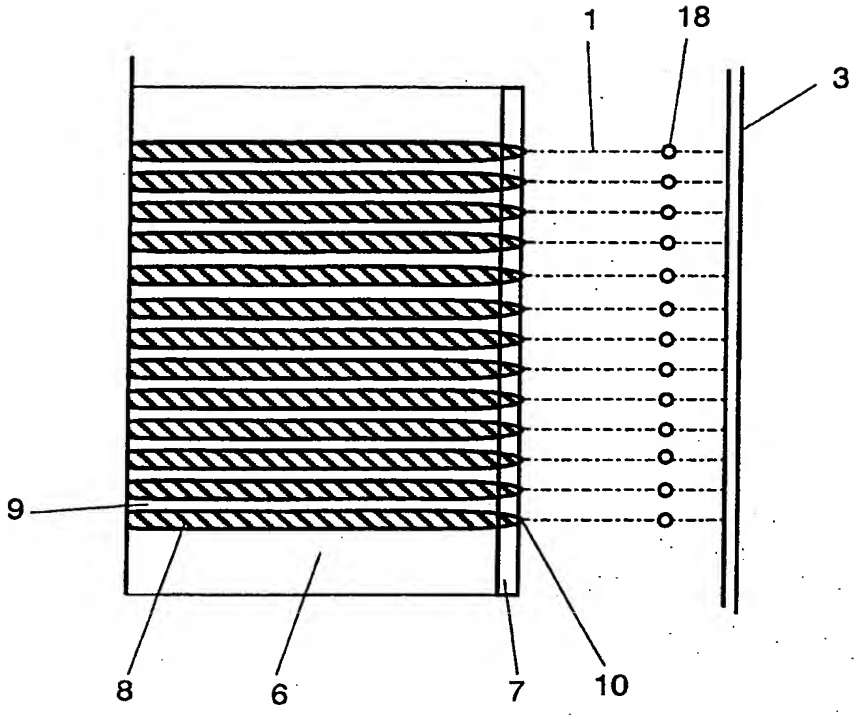


FIG. 5



Reference Numerals

1. Flight path
3. Recording medium
4. Deflecting electrode
5. Charging electrode
6. Actuator
7. Nozzle plate
8. Channel
9. Wall
10. Nozzle hole
11. Signal electrode
12. Printed circuit board
13. Ink supply hole
14. Actuator cover
15. Terminal
16. Bonding wire
17. Manifold
18. Ink drop
20. Ink jet head
21. Motor
22. Gear A
23. Gear B
24. Gear C
25. Feed screw A
26. Feed screw B
28. Rotating shaft
29. Deflecting electrode
30. Mounting board
31. Guide
32. Flame
33. Engaging section A
34. Engaging section B
35. Platen roll
36. Charging voltage generator
37. Deflecting voltage generator

# INTERNATIONAL SEARCH REPORT

Intern ial Application No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B41J2/09 B41J2/095

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
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Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category * | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
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| A | US 4 851 860 A (MUTOH MASAYUKI) 25 July 1989 (1989-07-25) column 4, line 32 - line 49 claim 1; figure 5 | 1,2 |
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